

TRMM

# Gridded

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# Abstract

*TRMM has many products that contain instantaneous or gridded rain rates often among many other parameters. However, these products because of their completeness can often seem intimidating to users just desiring surface rain rates. For example one of the gridded monthly products contains well over 200 parameters. It is clear that if only rain rates are desired, this many parameters might prove intimidating. In addition, for many good reasons these products are archived and currently distributed in HDF format. This also can be an inhibiting factor in using TRMM rain rates. To provide a simple format and isolate just the rain rates from the many other parameters, the TRMM product created a series of gridded products in ASCII text format. This paper describes the various text rain rate products produced. It provides detailed information about parameters and how they are calculated. It also gives detailed format information. These products are used in a number of applications with the TRMM processing system. The products are produced from the swath instantaneous rain rates and contain information from the three major TRMM instruments: radar, radiometer, and combined. They are simple to use, human readable, and small for downloading. They are available from anonymous ftp on [trmmopen.gsfc.nasa.gov](ftp://trmmopen.gsfc.nasa.gov).*

# **Background**

During the first 3 years of the Tropical Rainfall Measuring Mission (TRMM), all data was produced in Hierarchical Data Format (HDF) only. This is an extremely useful format that is self-describing, standardized, and provides a large set of useful tools for reading, creation, browsing, and displaying. Importantly for TRMM, HDF was also the standard format for NASA's Earth Observing Systems (EOS) missions.

However, HDF is complex. For people used to simple formats (e.g. GIS) or using other tools based on other formats, HDF appears to be difficult to use. The user must spend the time to learn the tools and their interaction with the underlying physical format.

Additionally, the TRMM data products themselves contain many parameters. For example, the monthly gridded Precipitation Radar (PR) product contains over 200 different science parameters. While other products do not have as many parameters, they nevertheless still contain more parameters than many scientists need.

This led the modeling community to request a simple format that contained just a few key parameters dealing with surface precipitation. They wanted a format which anyone could use without learning a complex set of tools or rules. They also wanted the physical format to be easy to use without worrying about byte-swapping, floating point formats, etc. Lastly, they wanted the data products to be small enough to retrieve quickly even over less than stellar internet connections.

This led the TRMM Project Scientist to organize a small group to develop the desired data products that met as many of the modeling community needs as possible. The group was composed of both scientists and computer scientists.

The working group determined that files using ASCII representation would be the most universally understood format. To ensure that the contents would be easily understandable only a small number of parameters would be included. Finally, a simple data “compression” scheme was adopted.

In 2002, all the TRMM data was put in the gridded text format and made publicly available on the TRMM anonymous ftp server.



# 3G68

This is the most used of the TRMM gridded text products. It contains the surface rain rates from the swath level 2 products from the TRMM Microwave Imager (TMI), the PR, and the Combined (PR & TMI).

A number of different suggestions were made by the working group for the base temporal aggregation. All could easily be accommodated by using a one hour grid. Additionally, each of these one hour grids would be packaged into a daily product.

Because of the TRMM coverage, it was determined that the best geographical gridding would be accomplished using  $.5^{\circ} \times .5^{\circ}$  spatial gridding. This was used by many of the standard TRMM gridded products.

## 3G68 Format:

All TRMM 3G products report their data on a universal grid where 90S, 180W is grid matrix ID (0,0) and 90N, 180E is grid matrix ID (360,720). While TRMM data is only collected from approximately 38S to 38N, reporting grid IDs based on the universal grid should permit easier combination with data from other satellites. The first 5 lines in the file contains header information. Some of these are intended only for visual scanning while other lines can be used by software to assist in setting up memory automatically.

### Header Lines

Line 1: Product\_ID (3G68),  
Algorithm Version,

Adjustment Algorithm ID (if any applied else NONE)

Adjustment Algorithm Version (if any else NONE)

TRMM Data Credit (NASA/NASDA/CRL)  
Date/Time Product Produced (in local time)

Line 2: Maximum Grid rows (Latitude)  
Maximum Grid columns (Longitude)  
Minimum Latitude represented in Grid  
Minimum Longitude represented in Grid  
Grid cell resolution  
Date of data in Product

Line 3: (TRMM specific information -- all numeric)  
Minimum Latitude for TRMM data  
Maximum Latitude for TRMM data  
Minimum Longitude for TRMM data  
Maximum Longitude for TRMM data

Line 4: keyword identified grid information  
Grid\_First\_Row  
Grid\_Center\_Latitude  
Grid\_First\_Column  
Grid\_Center\_Longitude  
Grid\_Cell\_Resolution

Line 5: Data line column identifications (exact strings)

hour  
minute  
row  
column  
tmi\_total\_pixels  
tmi\_rain\_pixels  
tmi\_mean\_rain  
tmi\_conv\_%  
pr\_total\_pixels  
pr\_rain\_pixels  
pr\_mean\_rain  
pr\_conv\_%  
comb\_total\_pixels  
comb\_rain\_pixels  
comb\_mean\_rain  
comb\_conv\_%

Sample Header lines from 3G68: word *line* does not appear in file

3G68 1.3 NONE NONE NASA/JAXA/CRL 2008-04-07T04:02UTC	<i>line1</i>
360 720 -90 -180 0.5 20080402	<i>line2</i>
-40 40 -180 180	<i>line3</i>
Grid_First_Row=0 Grid_Center_Latitude=-89.75 Grid_First_Column=0 Grid_Center_Longitude=-179.75 Grid_Cell_Resolution=0.5	<i>line4</i>
hour minute row column TMI_total_pixels TMI_rain_pixels TMI_mean_mm/hr TMI_%convective PR_total_pixels PR_rain_pixels	<i>line5</i>
PR_mean_mm/hr PR_%convective TCI_total_pixels TCI_rain_pixels TCI_mean_mm/hr TCI_%convective	<i>line5</i>

# Data Lines

Each data line contains the following information:

Hour, min, row of global .5 x.5 grid, column of global grid  
total pixels from 2A12 (TMI) in cell  
rainy pixels from 2A12 (TMI) in cell  
mean rain rate from 2A12 (TMI) in mm/hr  
percentage of rain from 2A12 (TMI) calculated to be convective

total pixels from 2A25 (PR) in cell  
rainy pixels from 2A25 (PR) in cell  
mean rain rate from 2A25 (PR) in mm/hr  
percentage of rain from 2A25 (PR) calculated to be convective

total pixels from 2B31 (Combined) in cell  
rainy pixels from 2B31 (Combined) in cell  
mean rain rate from 2B31 (Combined) in mm/hr  
percentage of rain from 2B31 (Combined) calculated to be convective

The mean rain rate is an unconditioned mean. This is the total rain (including zero rain) divided by the total pixel count but not including missing pixels.

## Compression Approach Used

In the event that a cell has a value for TMI but no PR pixel covered that cell, a 0 will be included for pr\_total\_pixels field but no other values appear for PR or Combined. This situation indicates that no PR pixel covered that grid box. This approach is taken to keep the file small because it does not print out missing values for the remainder of the PR or Combined fields.

In the event that a cell has no TMI value but does have PR values, the TMI total-pixels field will be set to 0 and rain-pixels set to 0. The mean rain and the convective percentage will be set to -9 to indicate that these are missing.

If neither the TMI nor the PR swath covered an hourly grid box, then no information is written to the file. This means that values in the file represent grid boxes that had data from at least 1 of the TRMM instruments. Users may safely assume that grid boxes with no values listed in the file did not contain data.

## Sample Data Line

A. (Case when there is no PR pixel in cell)

0 5 106 59 24 24 0.87 0 0

B. (Case when a line has both TMI and PR data)

0 10 109 109 48 0 0 0 133 32 0.39 34 133 32 0.35 28

C. (Case when a line has no TMI but has PR)

2 0 157 196 0 0 -9 -9 33 3 0.04 0 33 3 0.03 0

### *Explanation of Case A:*

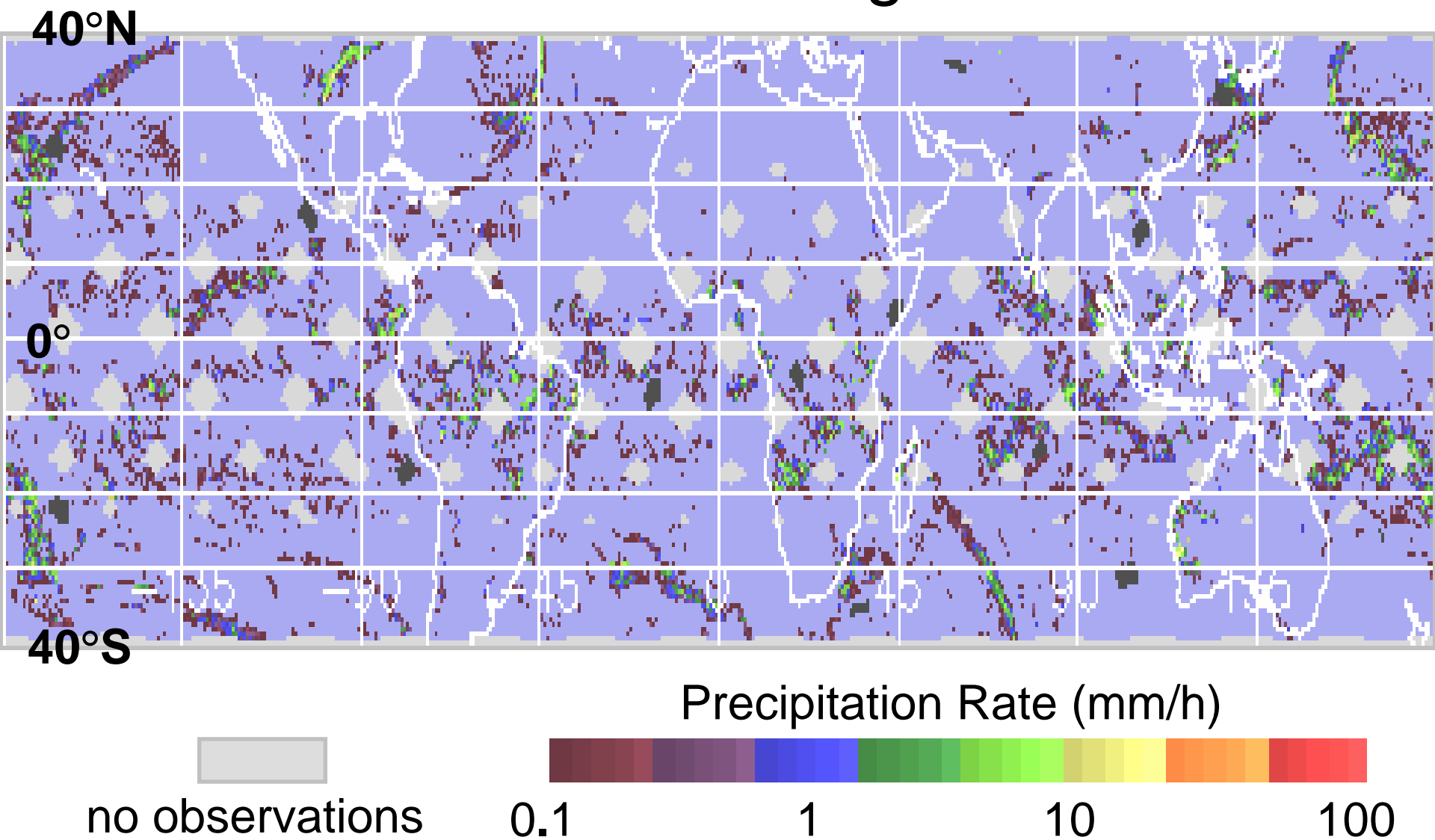
Hour 1(0 base), 5 mins [time of first pixel in grid box]

Grid box row 106 (0 base), column 59 (0 base) of global grid

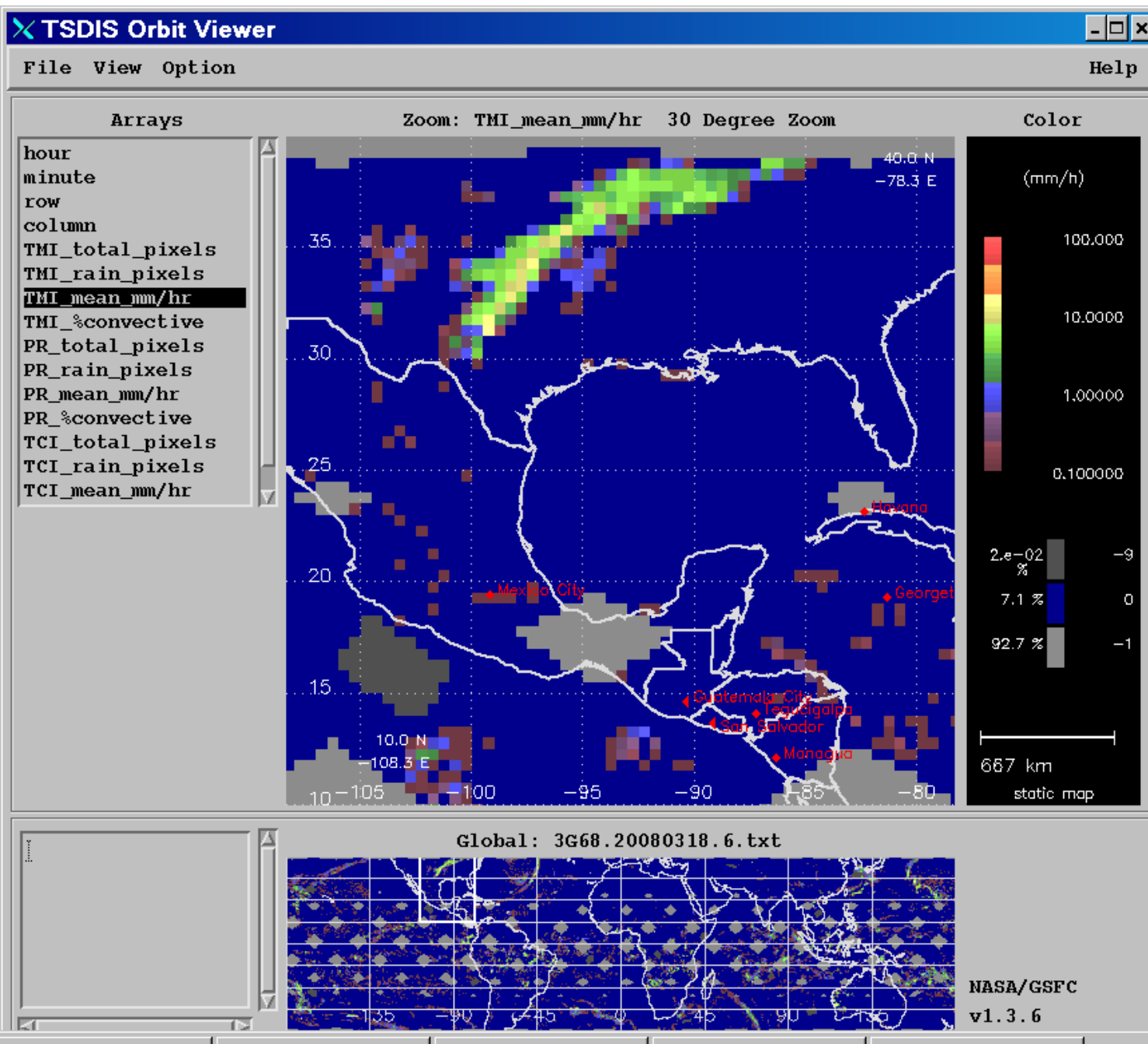
24 total pixels, 24 rainy pixels, 0.87mm/hr, 0% convective

The last 0 indicates that there are 0 PR pixels in the grid box

# 3G68 Global View of TRMM Coverage Area







# 3G68

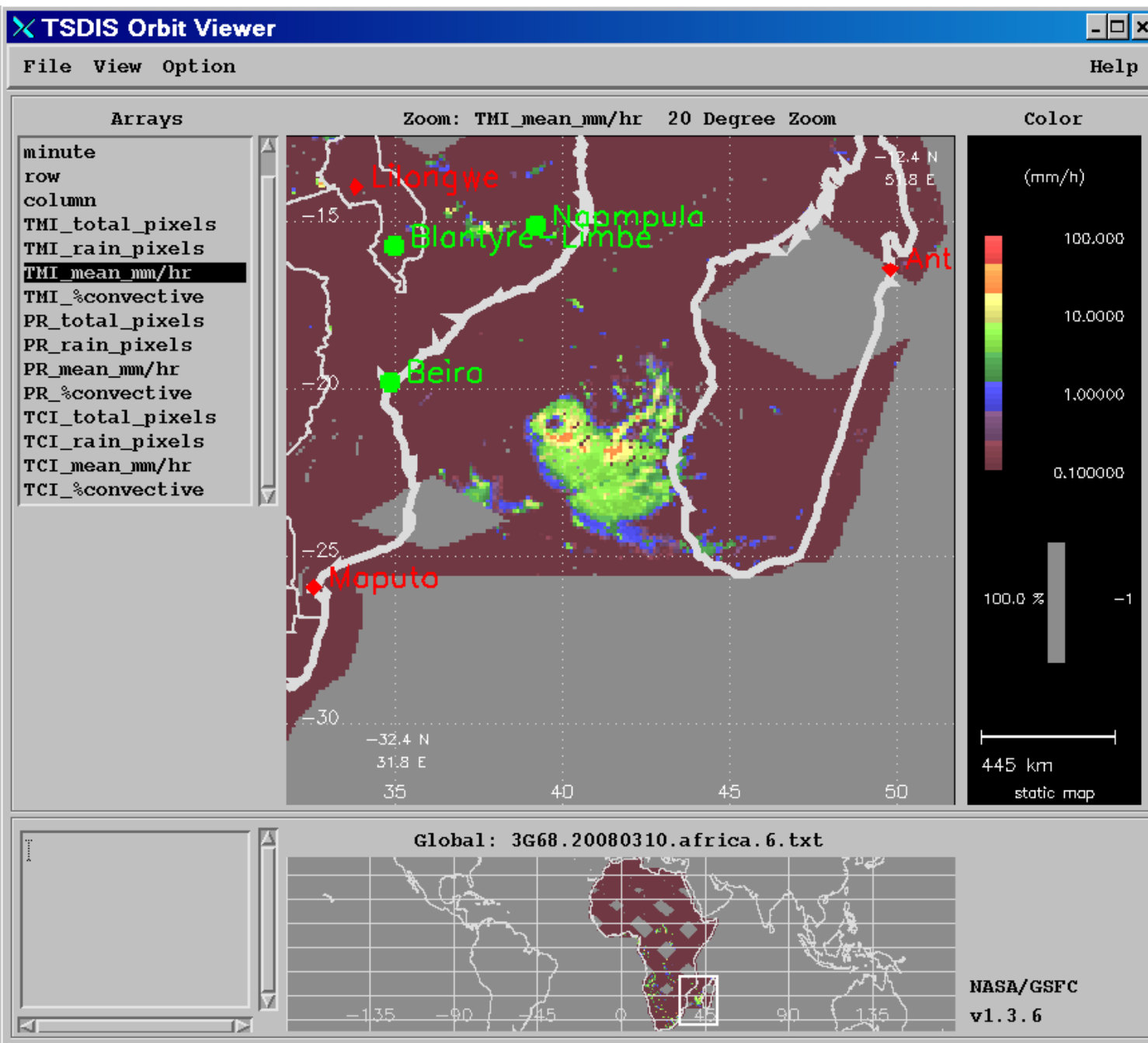
Heavy rains fell across the central United States in mid-March of 2008.

For more information:  
[http://trmm.gsfc.nasa.gov/publications\\_dir/midwest\\_flooding\\_13-20mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/midwest_flooding_13-20mar08.html)

# 3G68 Land

In 2003, scientists requested that a finer geospatial resolution be used to create 3G68 products over 3 land masses: Africa, South America, and Australia. They desired that these products continue to be hourly grids packaged as daily files but they wanted the grid box to be  $.1^{\circ} \times .1^{\circ}$ .

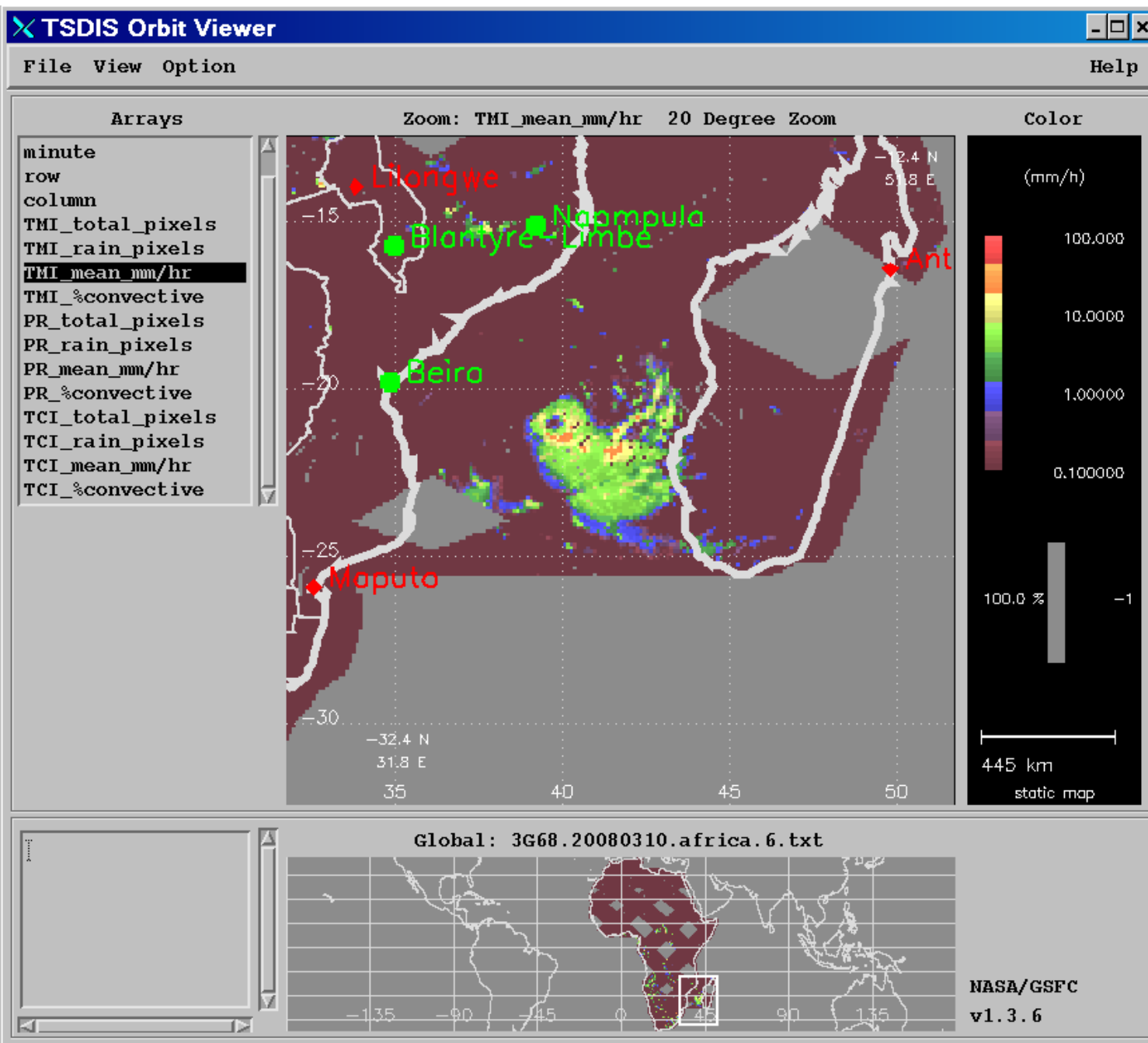
Three separate daily files are produced--one for each of the three land masses. The format for each of these files is EXACTLY the same as that described for the 3G68 global product. However, there are, naturally, more grid boxes. Once again, the TRMM coverage area is placed within a global grid. So, the row and columns are displacements in the global  $.1^{\circ} \times .1^{\circ}$  grid.



# 3G68 Africa TMI

Tropical Cyclone Jokwe on March 10, 2008 between the African Nation of Mozambique and the Island of Madagascar. The tropical cyclone had category 3 winds of 125 mph winds.

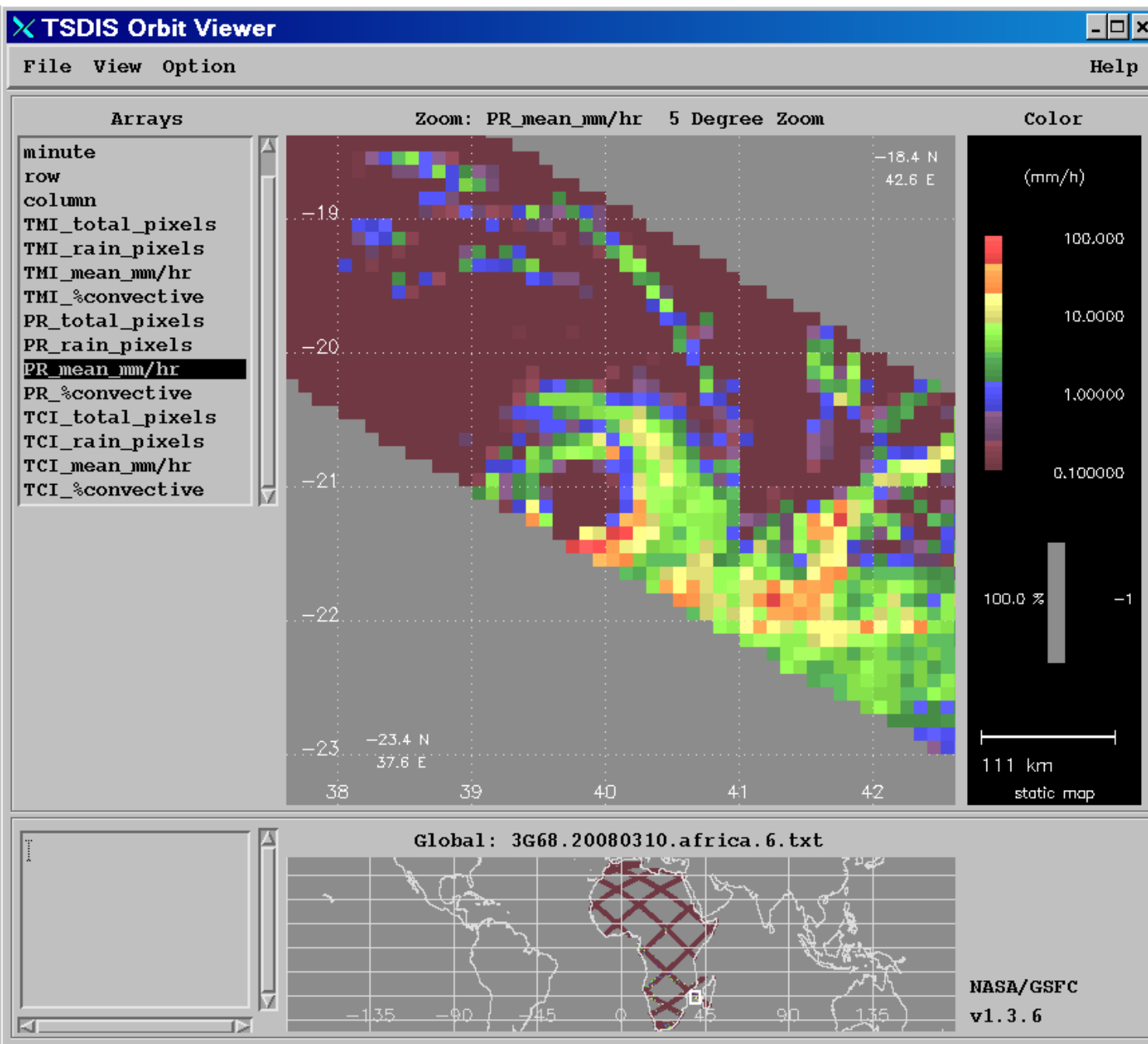
[http://trmm.gsfc.nasa.gov/publications\\_dir/midwest\\_flooding\\_13-20mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/midwest_flooding_13-20mar08.html)



# 3G68 Africa TMI

Tropical Cyclone  
Jokwe on March  
10, 2008  
between the  
African Nation of  
Mozambique and  
the Island of  
Madagascar.  
The tropical  
cyclone had  
category 3 winds  
of 125 mph  
winds.

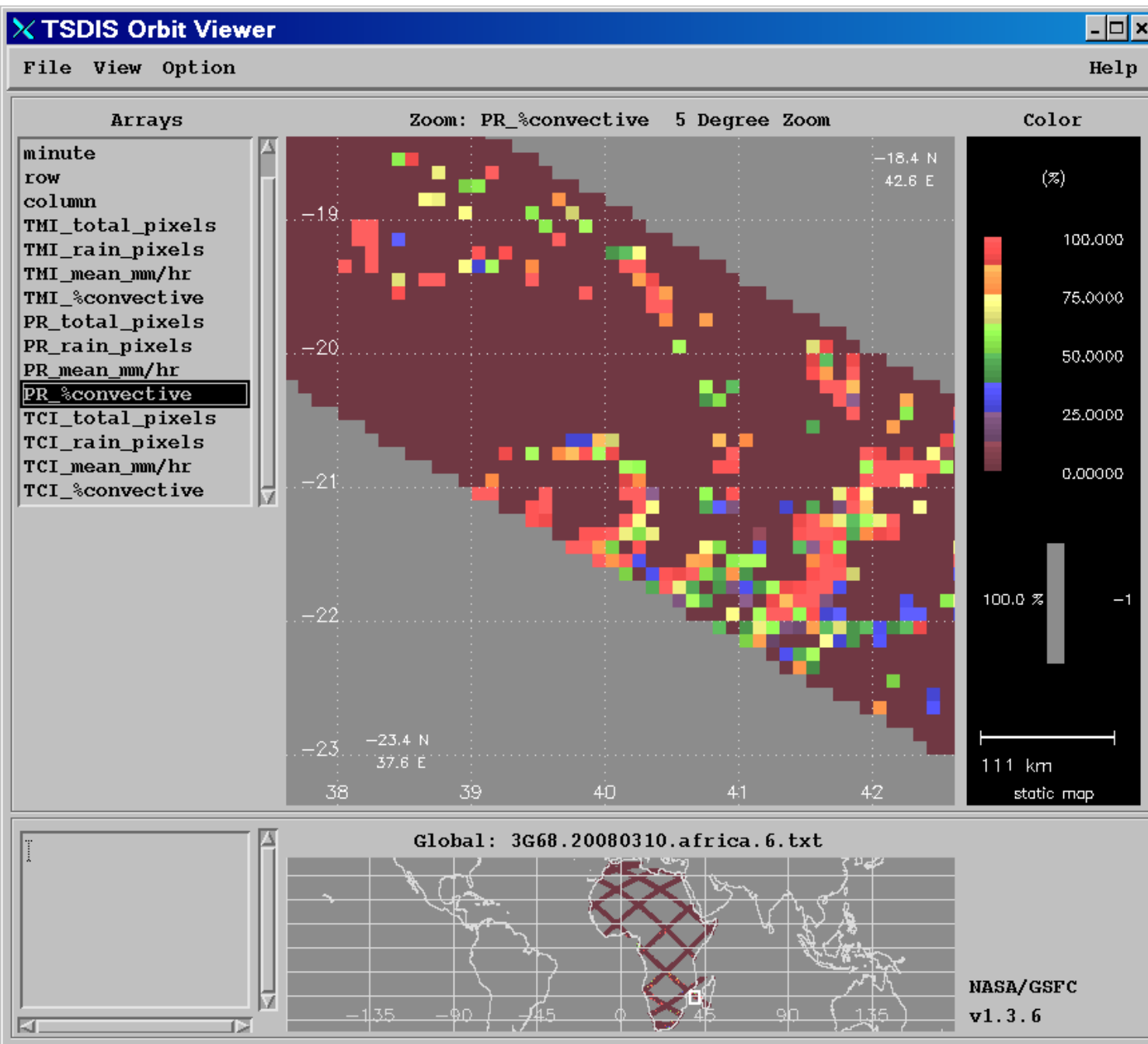
[http://trmm.gsfc.  
nasa.gov/publica  
tions\\_dir/midwes  
t\\_flooding\\_13-  
20mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/midwest_flooding_13-20mar08.html)



# 3G68 Africa Precipitation Radar

Tropical Cyclone  
Jokwe on March  
10, 2008  
between the  
African Nation of  
Mozambique and  
the Island of  
Madagascar.  
The tropical  
cyclone had  
category 3 winds  
of 125 mph  
winds.

[http://trmm.gsfc.  
nasa.gov/publica  
tions\\_dir/midwes  
t\\_flooding\\_13-  
20mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/midwest_flooding_13-20mar08.html)



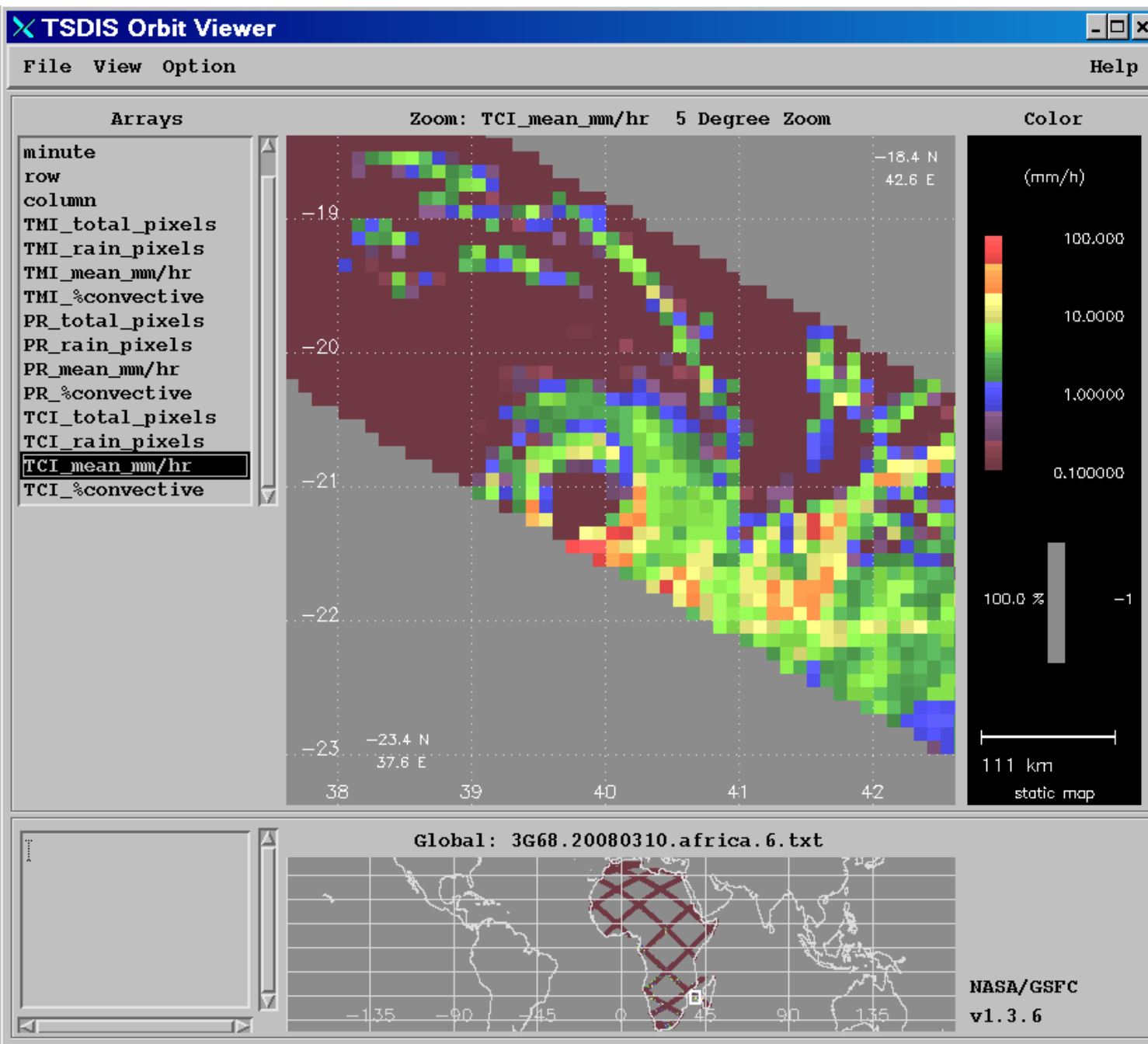
3G68

Africa

Precipitation  
Radar –  
% Convective

Tropical Cyclone  
Jokwe on March  
10, 2008  
between the  
African Nation of  
Mozambique and  
the Island of  
Madagascar.  
The tropical  
cyclone had  
category 3 winds  
of 125 mph  
winds.

[http://trmm.gsfc.  
nasa.gov/publica  
tions\\_dir/midwes  
t\\_flooding\\_13-  
20mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/midwest_flooding_13-20mar08.html)



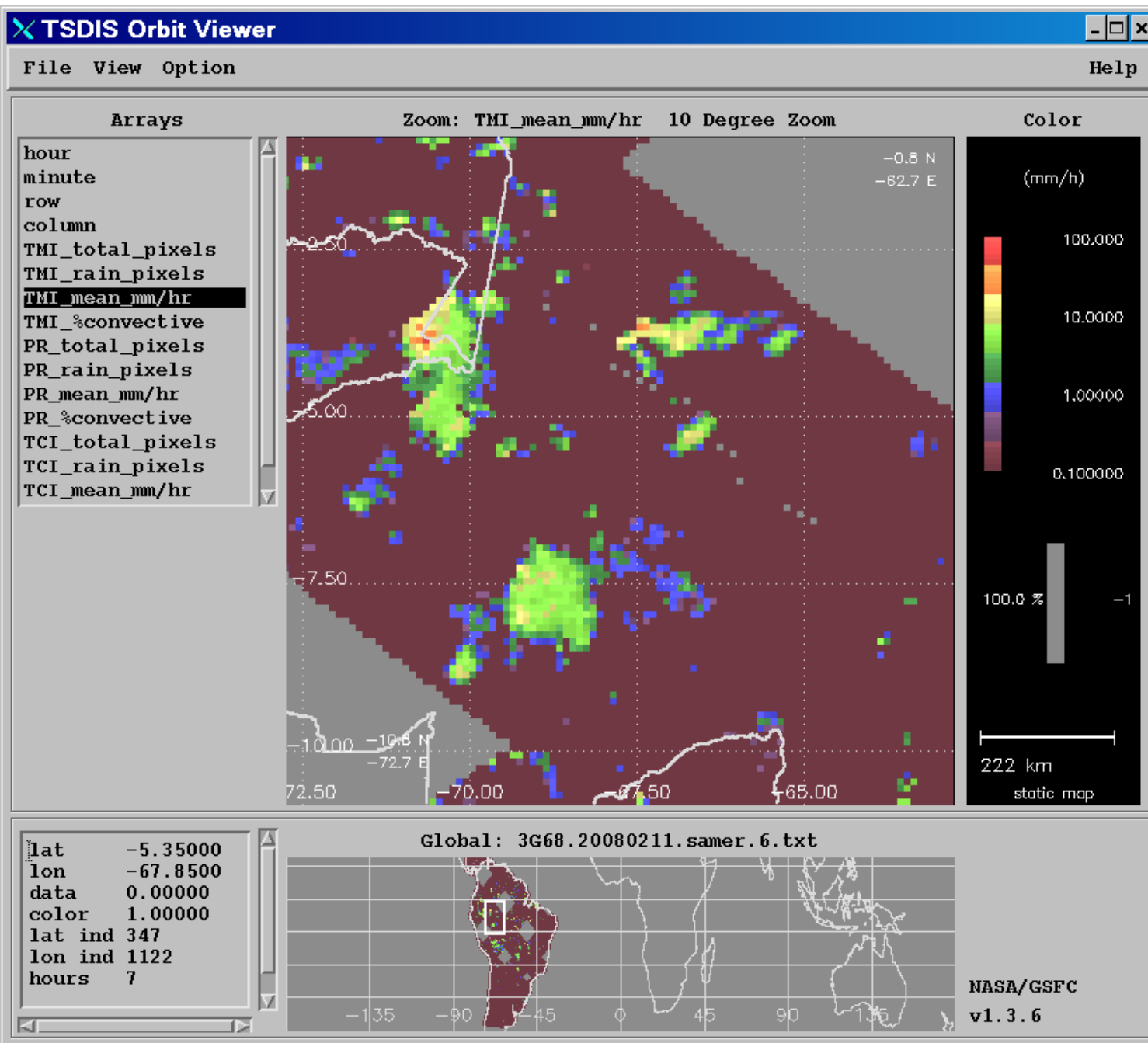
3G68

Africa

Combined  
TMI / PR

Tropical Cyclone  
Jokwe on March  
10, 2008  
between the  
African Nation of  
Mozambique and  
the Island of  
Madagascar.  
The tropical  
cyclone had  
category 3 winds  
of 125 mph  
winds.

[http://trmm.gsfc.  
nasa.gov/publica  
tions\\_dir/midwes  
t\\_flooding\\_13-  
20mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/midwest_flooding_13-20mar08.html)



## 3G68 South American

Heavier than  
normal  
precipitation fell  
in South  
American during  
February of  
2008, which  
caused flooding.

For more  
information:  
[http://trmm.gsfc.  
nasa.gov/publica  
tions\\_dir/south\\_a  
merica\\_flooding\\_  
feb-mar08.html](http://trmm.gsfc.nasa.gov/publications_dir/south_america_flooding_feb-mar08.html)



3G68

Africa

Hour of the day

(hour)

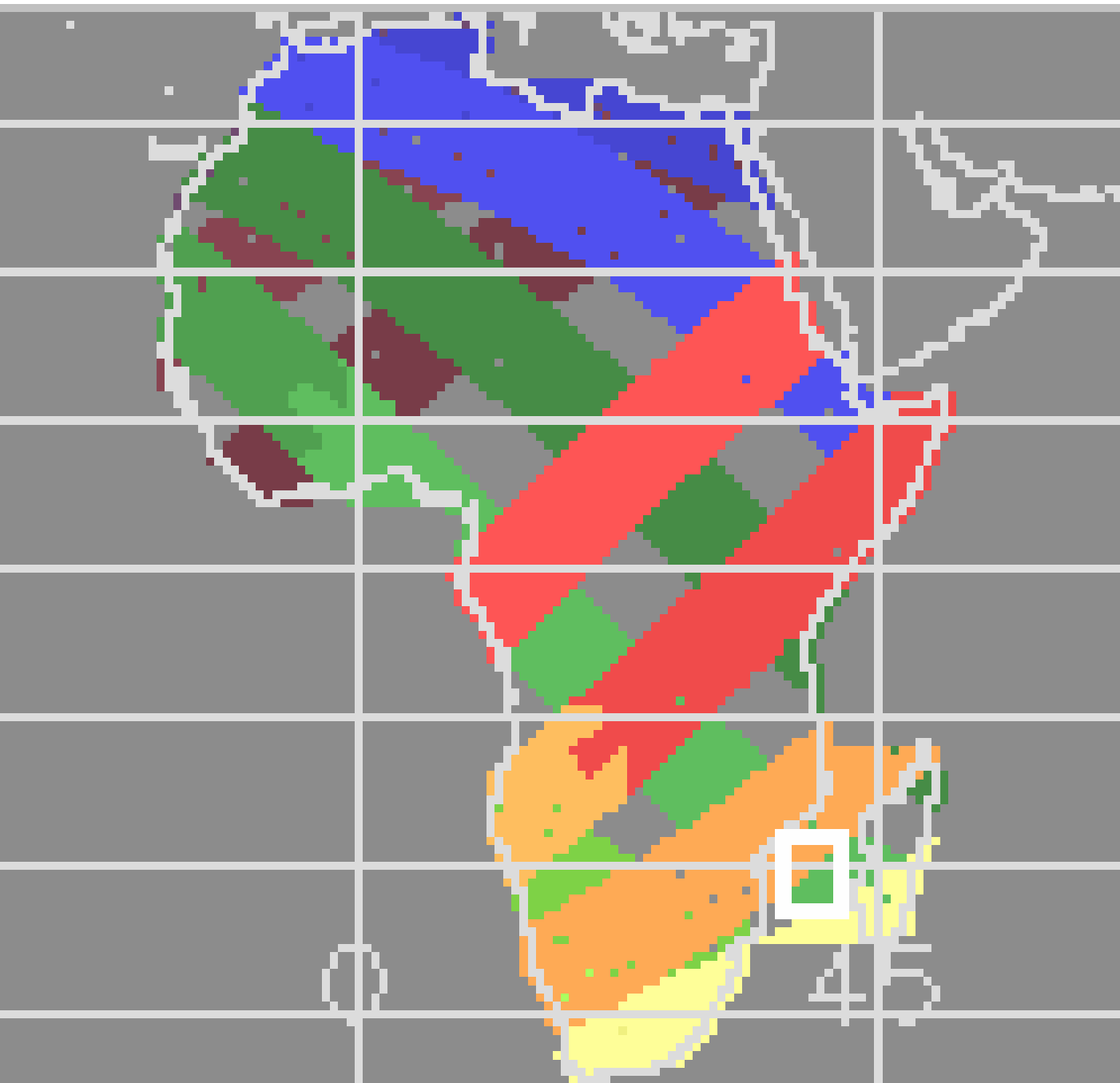
23.0000

17.2500

11.5000

5.7500

0.0000



# 3G01

With the success of the rain retrieval 3G68 and 3G68Land gridded text files, the science community asked for an analogous text format for 2 channels from the Visible Infrared Scanner (VIRS). They requested the two infrared channels with units in  $T_b$ : channel 4, the 10.8 micron channel, and channel 5, the 12 micron channel. Each channel was put in its own daily text file: 3G01-4 and 3G01-5.

The radiances contained in the L1B VIRS swath files are converted to brightness temperature. The data are gridded on a global grid of  $.5^\circ \times .5^\circ$ .

## Format

The 3G01 product provides:

- mean brightness temperature
- maximum brightness temperature
- minimum brightness temperature
- standard deviation

A lookup table is used to convert VIRS channel 4 radiances to brightness temperature. While the table is calculated in .5 deg steps, the conversion applies a linear interpolation to provide the actual printed value.

All TRMM 3G products report their data on a universal grid where 90S, 180W is grid matrix ID (0,0) and 90N, 180E is grid matrix ID (360,720). While TRMM data is only collected from approximately 38S to 38N, reporting grid IDs based on the universal grid should permit easier combination with data from other satellites.

# Header Lines

Line 1: Product\_ID (3G01),  
Algorithm Version,  
Adjustment Algorithm ID (if any applied else NONE)  
Adjustment Algorithm Version (if any else NONE)  
TRMM Data Credit (NASA/NASDA/CRL)  
Date/Time (local time) Product Produced

Line 2: Maximum Grid rows (Latitude)  
Maximum Grid columns (Longitude)  
Minimum Latitude represented in Grid  
Minimum Longitude represented in Grid  
Grid cell resolution  
Date of data in Product

Line 3: (TRMM specific information -- all numeric)  
Minimum Latitude for TRMM data  
Maximum Latitude for TRMM data  
Minimum Longitude for TRMM data  
Maximum Longitude for TRMM data

Line 4: keyword identified grid information

Grid\_First\_Row

Grid\_Center\_Latitude

Grid\_First\_Column

Grid\_Center\_Longitude

Grid\_Cell\_Resolution

Line 5: Data line column identifications

hour

minute

row

column

VIRS\_total\_pixels

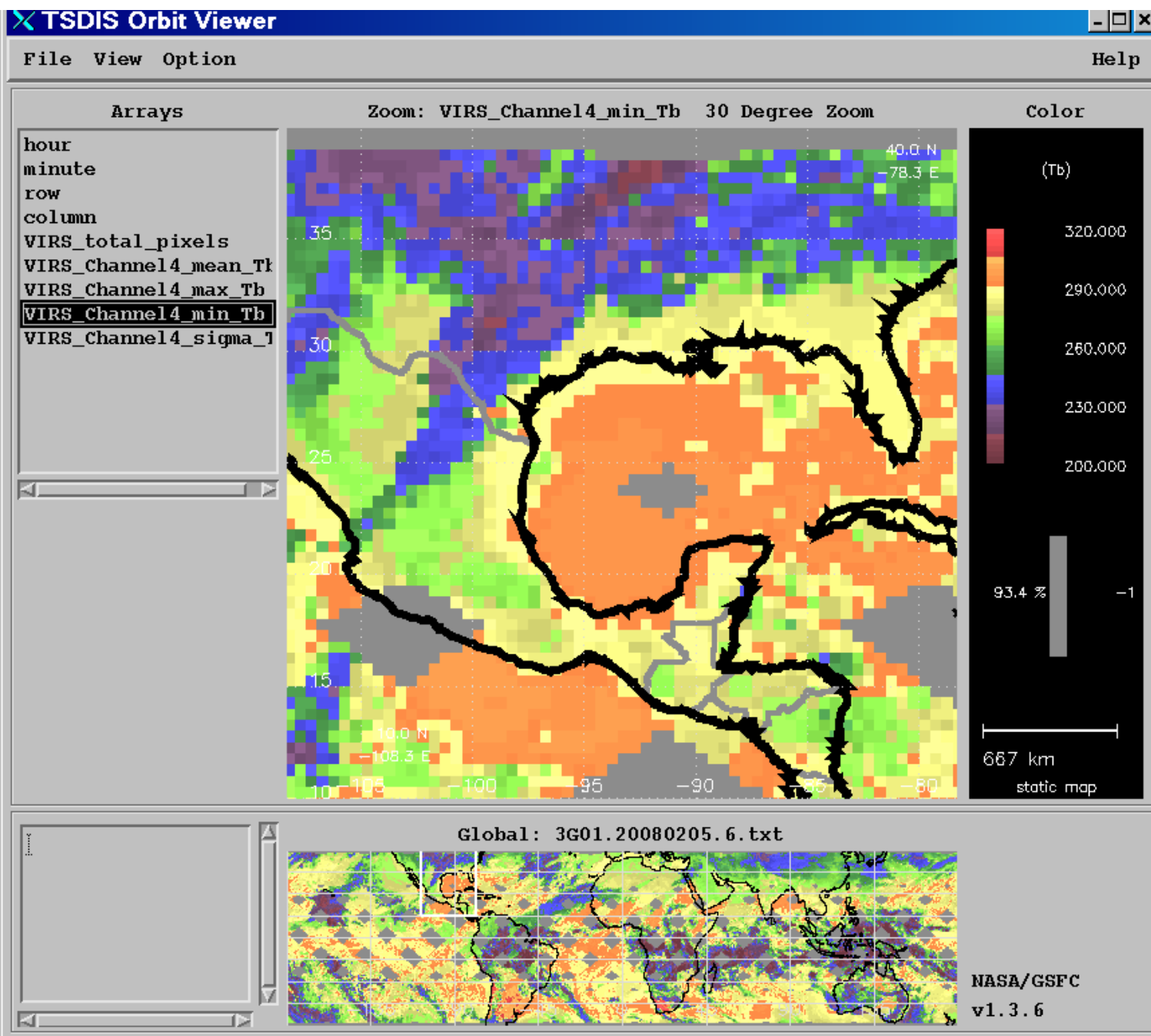
VIRS\_Channel4\_mean\_Tb

VIRS\_Channel4\_max\_Tb

VIRS\_Channel4\_min\_Tb

VIRS\_Channel4\_sigma\_Tb

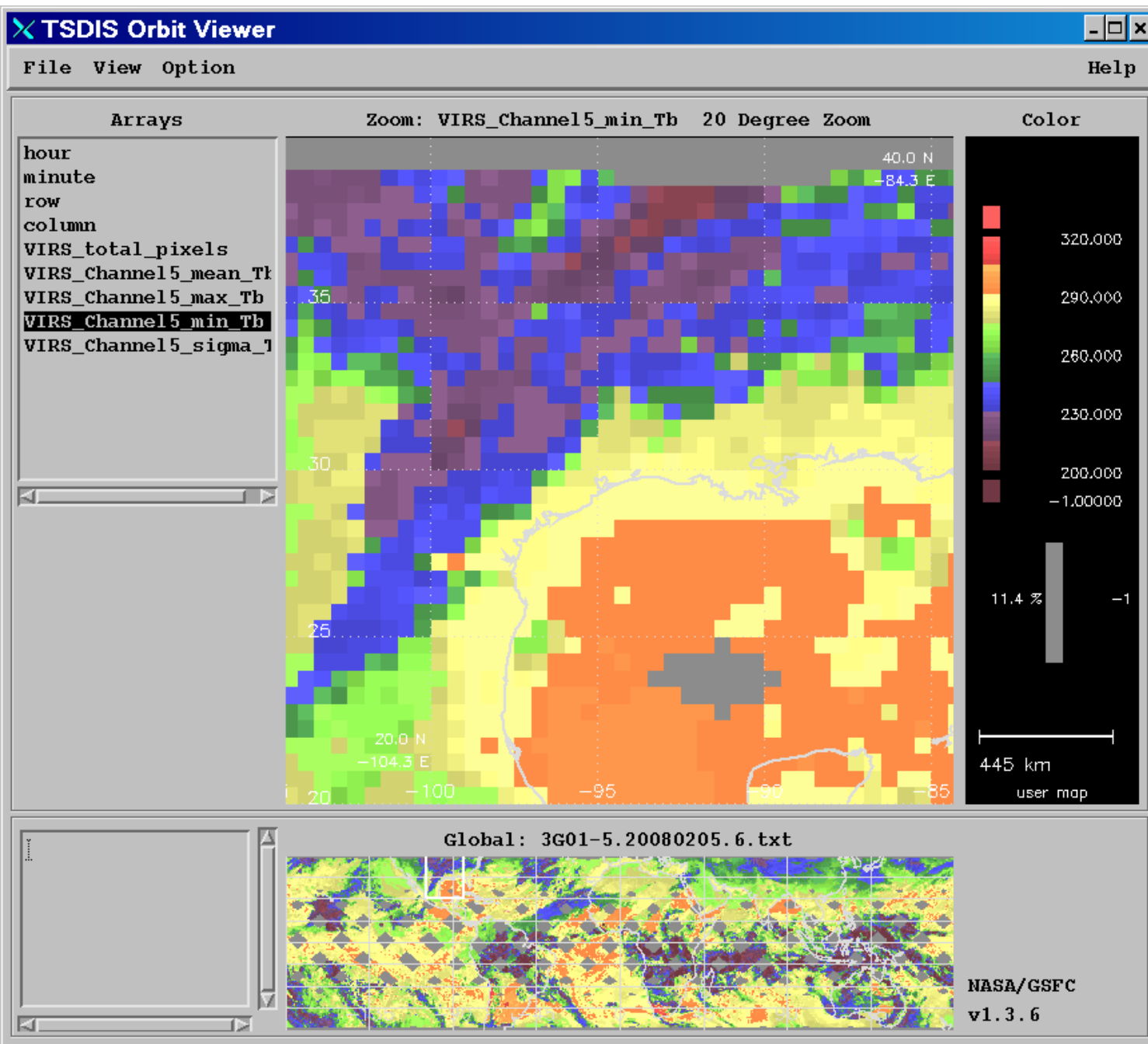
These header lines are almost identical with those contained in the 3G68 products but modified to represent the VIRS data and the fact that each data line contains only a single channel value for the hour and grid location.



# 3G01 channel 4: 10.8 micron Infrared Brightness Temperature

An outbreak of tornadoes struck the southern United States on February 5 of 2008. The 3G01 image shows the minimum 10.8 micron infrared brightness temperature observed in each grid box. Values below 230 K are sometimes associated with intense convective storms, such as tornado-producing storms.

For more information:  
[http://trmm.gsfc.nasa.gov/publications\\_dir/6au08\\_tornado.html](http://trmm.gsfc.nasa.gov/publications_dir/6au08_tornado.html)



## 3G01 channel 5:

An outbreak of tornadoes struck the southern United States on February 5 of 2008. The 3G01 image shows the minimum 12 micron infrared brightness temperature observed in each grid box. Values below 230 K are sometimes associated with intense convective storms, such as tornado-producing storms.

For more information:  
[http://trmm.gsfc.nasa.gov/publications\\_dir/6aug08\\_tornado.html](http://trmm.gsfc.nasa.gov/publications_dir/6aug08_tornado.html)

# **Conclusions**

The gridded text products contain only the rain related parameters, are in a simple universal format, and greatly reduce the volume of data that must be retrieved to get basic surface precipitation information.

These products are available via anonymous ftp from [trmmopen.gsfc.nasa.gov](http://trmmopen.gsfc.nasa.gov) in the directories `pub/3G68`, `pub/3G68Land`, `pub/3G01-4`, and `pub/3G01-5`. The `pub` directory contains README files for 3G68, 3G68Land, and the 3G01 products. These describe the file structure and calculations used in greater detail.

The gridded text products are extensively retrieved and used. They are among the most requested TRMM products.





## **TRMM gridded text products**

**E. Stocker** (1)

(1) NASA/GSFC Code 610.2

TRMM has many products that contain instantaneous or gridded rain rates often among many other parameters. However, these products because of their completeness can often seem intimidating to users just desiring surface rain rates. For example one of the gridded monthly products contains well over 200 parameters. It is clear that if only rain rates are desired, this many parameters might prove intimidating. In addition, for many good reasons these products are archived and currently distributed in HDF format. This also can be an inhibiting factor in using TRMM rain rates. To provide a simple format and isolate just the rain rates from the many other parameters, the TRMM product created a series of gridded products in ASCII text format. This paper describes the various text rain rate products produced. It provides detailed information about parameters and how they are calculated. It also gives detailed format information. These products are used in a number of applications with the TRMM processing system. These products are produced from the swath instantaneous rain rates and contain information from the three major TRMM instruments: radar, radiometer, and combined. They are simple to use, human readable, and small for downloading. They are available from anonymous ftp on [trmmopen.gsfc.nasa.gov](http://trmmopen.gsfc.nasa.gov).